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STUDY OF AIR POLLUTION AROUND THE NITROGEN FERTILIZER PLANT NEAR STARA ZAGORA AND ITS EFFECT ON THE HEALTH OF THE POPULATION

[Prouchsvane zamŭrsyavaneto na atmosferniya vŭzdukh v rayona na azotnotoroviya zavod kray Stara Zagora i vliyanieto mu vŭrkhu zdraveto na naselenieto]

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STUDY OF AIR POLLUTION AROUND THE NITROGEN FERTILIZER PLANT NEAR STARA ZAGORA AND ITS EFFECT ON THE HEALTH OF THE POPULATION

ABSTRACT. Atmospheric air around the plant was found to be considerably polluted by sulfur dioxide, nitrogen oxides, and ammonia. The initial level of damage to adaptive reactions, the presence of stressed protective-compensatory body mechanisms, disturbance of mineral metabolism and oxidation-reduction processes, and changes in the blood picture and in the immunobiological state are established. The polluted atmospheric air around the plant has a specific, unpleasant, smell with adverse effects on ventilating homes, and causes subjective complaints by some of the population. The study has resulted in the adoption of a preventive program designed to improve the sanitation conditions of atmospheric air around the plant.

The need for mineral fertilizers for our socialist agriculture led to the rapid development of this important branch of the chemical industry.

The nitrogen fertilizer plant began production in 1963. It was built on the eastern part of the Stara Zagora plain, about 8 km to the east of Stara Zagora. This area has a transient continental climate, with an average annual temperature of 12.2°C. The prevailing winds are from the northeast and east. Characteristic of the area is a high percentage of days with calm weather, 59.4%.

The principal pollutants emitted by the plant are hydrogen sulfide, nitrogen oxides, ammonia, and sulfur dioxide. Dust and carbon monixide are emitted, but in smaller quantities. The plant has four chimneys ranging in height from 80 to 125 m. None of the shops are equipped with scrubbers.

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The purpose of this study was to determine the level of air pollution around the plant, and its effect on the health of the population.

Arrangement and procedures. Air samples were taken for seven days out of each month for two years in five settlements located in a fan shape around the plant at distances from 3 to 9 km (Figure 1) from it. These samples were analyzed for the following indices, using the procedures indicated for each. For hydrogen sulfide - nephelometrically with silver nitrate; for nitrogen oxides - colorimetrically with Griess reagent; for ammonia - colorimetrically by the indophenol method; for sulfur dioxide - nephelometrically with barium chloride; for dust - by the weight-aspiration method; for soot - by the standard scale method. Air samples were taken in the smoke plume in the spring and the fall of 1969, and analyzed for content of hydrogen sulfide and nitrogen oxides in order to establish the maximum pollutionin the area by directions, and to determine the degree of dispersion of the pollutants. This procedure took 15 days per season, in westerly, southwesterly, and southerly directions, corresponding to the wind rose and the terrain relief.

We made a dynamic study of a group of people in 1968 and 1969 in order to determine the influence of atmospheric pollutants on the health of those living in the vicinity. Hematological and biochemical examinations were made of 12-14 year old students in Stara Zagora (southeastern part), and in the villages of Khrishcheni, Dŭlboki, and Preslaven. A group of 4-6 year old children from the kindergarten near the plant (500 m away) was examined. Students from the village of Dŭbovo (12-14 years of age), 35 km from the plant, were used as a control. The study was made during the fall and

winter and covered a two year period. The following indices and procedures were used. Hemoglobin - by the Crosby and Canon procedure, red cells, white cells, eosinophilia - by hemacytometer, reticulocytes - by the Heilmeier method, differential picture of white cells - by Romanowsky, phagocytic activity of leukocytes - by V. kh. Vŭlchanov; methemoglobin - by David, Golek, Srbova [4], histaminase activity in the blood - by Madgio [13] as modified by P. Kirchev and T. Nikolov, micromethod of S. Slavkov; reduced glutathion in the blood - by Grinert and Phillips [10], catalase activity in the blood - by Bakh and Zubkova [2]; alkaline phosphatase, inorganic serum phosphorous and calcium - by Karakashov and Vichev [6], urinary vitamin C - by Row and Kyudŭr [11], urinary 17-ketosteroids - by Shefer and Yefstifeyeva [9], inorganic urinary ester-combined sulfates and neutral sulfur - by the Balabayeva [3] complexometric method.

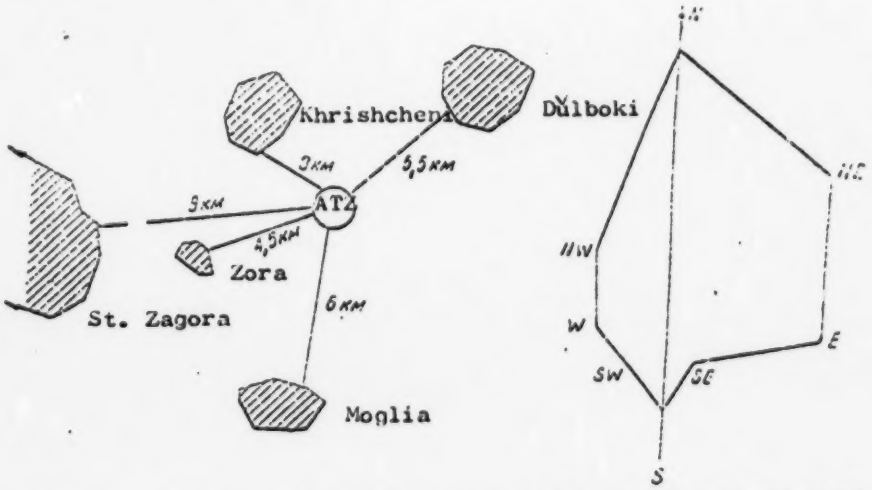

Figure 1. Sketch of the points around the plant and the wind rose.

A statistical questionnaire type study was made in the settlements observed in order to determine influence of pollutants emitted into the air by the plant had on the population. One thousand persons of both sexes

in the over 18 age group who did not work in the plant were questioned. The statistical questionnaire method was used in conjunction with personal discussion. The indices on the questionnaire card included whether a specific disagreeable odor was present in the home, subjective complaints, effect on home ventilation, whether any difference could be noted in degree of air pollution as compared to past years, and so on.

Results and Discussion

1393 samples of the primary pollutant, hydrogen sulfide were analyzed. The mean concentrations measured in 1968, were in excess of the maximum permissible concentration (MPC) (0.008 mg/m^3) by a factor of 1.5, and maximum values were in excess of the standard by a factor of 37.5. The maximum pollution was found in Stara Zagora in 1968 (Table 1).

Table 1. Hydrogen sulfide contents (MPC 0.008 mg/m^3) in 1968

No.	Point	No. samples	Max. conc. mg/m^3	Mean conc. mg/m^3	Samples in excess of MPC, %	t	P
1	St. Zagora	201	0.300	0.0240±0.004	47.6	2.2	<0.05
2	Zora	207	0.240	0.0116±0.002	26.6	1.6	<0.05
3	Khrishcheni	173	0.130	0.0129±0.004	56.6	1.3	<0.05
4	Dŭlboki	204	0.270	0.0102±0.001	21.6	2.2	<0.05
5	Mogila	142	0.083	0.0060±0.009	15.3	2.2	<0.05

1969

No.	Point	No. samples	Max. conc. mg/m^3	Mean conc. mg/m^3	Samples in excess of MPC, %	t	P
1	St. Zagora	96	0.0666	0.009 ±0.002	27.0	4.5	<0.01
2	Zora	110	0.0645	0.0130±0.003	46.0	4.3	<0.01
3	Khrishcheni	103	0.0676	0.0092±0.004	36.0	2.3	<0.05
4	Dŭlboki	74	0.1080	0.0127±0.003	35.0	4.2	<0.01
5	Mogila	98	0.0790	0.0075±0.003	28.5	2.5	<0.05

In 1969, the mean values were in excess of the MPC by a factor of 1.7 in two of the settlements (Zora and Dŭlboki) but were about standard in the others. While absolute values of means and maximum concentrations show a falling trend, the percentage of samples exceeding the MPC remained at about the same level, at about 35% during the two years of observations. This means there has been steady pollution of the air around the plant by a high concentration of heavily toxic pollutants. The maximum air pollution by hydrogen sulfide in the observed settlements differed by months, depending on wind direction, and speed.

The second important atmospheric pollutant in the area is nitrogen oxides. The mean value for the 2669 samples analyzed (Table 2) during the observation period was below the MPC (0.085 mg/m^3), but was considerably higher in 1969 than in 1968. The maximum concentration in 1968, was in excess of the standard by a factor of 11, and by a factor of 9 in 1969. The percentage of the samples exceeding the MPC was 25% and 9%, respectively. The reduction in concentrations of nitrogen oxides in the air in the observed settlements during this period can be explained by the 50% reduction in nitric

acid production. A correlation was established between the mean values and the samples exceeding the MPC (Stara Zagora, Mogila, Zora).

Table 2. Nitrogen oxides content (MPC 0.085 mg/m^3) in 1968

No.	Point	No. samples	Max. conc. mg/m^3	Mean conc. mg/m^3	Samples in excess of MPC, %	t	P
1	St. Zagora	393	0.936	0.106±0.01	42.8	2.1	<0.05
2	Zora	374	0.770	0.065±0.01	25.2	-2.0	<0.05
3	Khrishcheni	343	0.630	0.032±0.009	20.4	-2.5	<0.05
4	Dŭlboki	362	0.540	0.041±0.005	12.4	-8.8	<0.01
5	Mogila	362	0.834	0.075±0.01	29.4	-1.0	<0.05

1969

No.	Point	No. samples	Max. conc. mg/m^3	Mean conc. mg/m^3	Samples in excess of MPC, %	t	P
1	St. Zagora	168	0.330	0.0461±0.041	12.5	-3.5	<0.01
2	Zora	166	0.033	0.0274±0.007	8.4	-8.2	<0.01
3	Khrishcheni	169	0.135	0.0228±0.005	4.1	-12.4	<0.01
4	Dŭlboki	166	0.640	0.0284±0.009	6.6	-6.2	<0.01
5	Mogila	166	0.762	0.0483±0.04	42.6	-3.7	<0.01

The 2188 samples analyzed showed a considerable concentration of ammonia in all settlements. This was particularly true in 1968, when 60% of the samples showed a content in excess of the MPC (0.2 mg/m^3). The mean was a factor of 1.5, the maximum a factor of 9 times the standard. Regulation of working conditions in the "Karbamid" shop, and elimination of certain technological errors, resulted in a decrease in the ammonia concentration by a factor of almost 3 in 1969. Neverthelss, some 20% of the samples exceeded the MPC.

The maximum concentrations of sulfur dioxide measured in all settlements were below the MPC during the observation period. Similar results were obtained for dust and soot content.

The pollution by hydrogen sulfide in the samples taken in the smoke plume were many times in excess of the pollution by nitrogen oxides (Table 3).

Table 3. Measurements of concentrations in the smoke plume

1 №	2 Расстояние в м	3 Азотных окисл				4 Сероводород			
		5 Серий проб	6 макс. к-я, мг/м³	7 средняя концентр., мг/м³	8 проб выше ПДК %	5 Серий проб	6 макс. к-я, мг/м³	7 средняя к-я, мг/м³	8 проб выше ПДК %
1	200—500	203	0,242	0,0401±0,002	9,8	98	0,156	0,0295±0,002	81,6
2	500—1500	310	0,976	0,0385±0,003	1,6	142	0,211	0,0287±0,002	75,0
3	1500—2500	223	0,198	0,0382±0,002	1,3	95	0,236	0,0295±0,003	70,5
4	2500—3500	172	0,668	0,0349±0,004	9,6	82	0,105	0,0273±0,003	70,7
5	3500—4500	103	0,217	0,0359±0,004	1,6	48	0,157	0,0341±0,005	73,0
6	4500—6000	29	0,161	0,0340±0,007	6,6	17	0,178	0,0203±0,005	64,0
7	6000—8000	38	0,108	0,0248±0,004	8,0	14	0,080	0,0362±0,005	78,0
8	8000—10000	—				2	0,0	0,0	0,0
9	over 10 000	—				2	0,026	0,0198±	100,0

Key:

1 - no.; 2 - distance in m; 3 - nitrogen oxides; 4 - hydrogen sulfide; 5 - number of samples; 6 - maximum concentration, mg/m^3; 7 - mean concentration, mg/m^3; 8 - samples in excess of MPC, %.

The number of samples that exceeded the MPC at all distances is about 7[illegible]%. Comparatively speaking, pollution is lower 4000 to 6000 m from the plant (64%), as well as beyond 8000 m. The mean value for all distances exceeded the MPC by a factor of 2-4, and the maxima were above the standard by a factor of as much as 30. The mean concentrations of nitrogen oxides in the smoke plume are below the MPC at all distances, and the maxima are of the same order of magnitude for the permanent settlements, above the MPC by a factor of as much as 12.

The results of hematological studies showed a well defined reduction in the hemoglobin level in children living in the plant area, as compared to that of the control in the village of Dŭbovo. This is very definite among the children in Preslaven, Stara Zagora, Dŭlboki, and Khrishteni in 1968, as well as in Stara Zagora in 1969. No deviations were found in the number of leukocytes, or in leukocytic morphology. A statistically significant increase was observed in the number of eosinophil cells (by hemocytometer) among the population of all villages as compared to the control. This is well marked in 1968 in Stara Zagora, Preslaven and Khrishteni, and in the kindergartens near the plant, and increased even more significantly in 1969. This eosinophilia could be taken as a manifestation of adults becoming allergic to atmospheric pollutants, because massive deparazitization was not to be carried out among the schoolchildren in the village. A statistically significant increase was observed in phagocytic activity of the leukocytes in the students studied as compared to those in Dŭbovo, in terms of the phagocytic index ratio, and the percentage of phagocytized cells. This is well manifested in Khrishteni, Preslaven and Stara Zagora. These changes in the immunobiological state of the body could be taken as a manifestation of the effect of atmospheric pollutants.

One of the main signs of the toxic action of hydrogen sulfide is the disturbance in the mineral metabolism. Changes in calcium and phosphorus content, and the activity of the alkaline phosphatase, could be ascribed to the pollutants. Table 4 shows that in 1968 there were no deviations from the standard in serum calcium and phosphorus, whereas the activity of the alkaline phosphatase tended to increase, particularly among the children in Dŭlboki and Khrishteni. In 1969, serum calcium was within normal limits,

but was lower for phosphorus (Preslaven, Dŭlboki). Statistically significant as well was the drop in the activity of serum alkaline phosphatase among children who lived in the third village near the plant. This can be explained by the inhibitive effect hydrogen sulfide has on alkaline phosphatase activity and therefore on the level of serum inorganic phosphorus. These data indicate that hydrogen sulfide will continue to be harmful to adults in this area.

A characteristic index of the effect of nitrogen oxides is the methemoglobin level. The elevated level found in children in the area in 1968 (Table 5), runs parallel with the increase in reduced glutathione in the blood, and probably is a compensatory reaction. In 1969, the concentrations of methemoglobin in the blood of those studied were lower, and so too were the reduced glutathione values, which is in accordance with the lower concentration of nitrogen oxides in the air. It should be pointed out that so substantial a reduction in reduced glutathione, in some cases as much as 50%, cannot be explained simply by the reduced concentrations of nitrogen oxides. It probably has something to do with the effect of sulfur gases. The elevated content of pyruvic acid in the blood of the children studied corroborated the data in the literature on the effect of nitrogen oxides on carbohydrate metabolism. The effect of the sulfur gases, that of sulfur dioxide in particular, which leads to the accumulation of pyruvic acid by blocking the thiamine-pyrophosphate, should be added to this effect.

Table 4. Calcium and phosphorus content and activity of alkaline phosphatase in the blood of students living near the plant - Stara Zagora area in 1968 and 1969

Populated point	1968					1969				
	Number studied	Calcium, mg%	Phosphorus, mg%	Ca/P	Alkaline phosphatase	Number studied	Calcium, mg%	Phosphorus, mg%	Ca/P	Alkaline phosphatase
Stara Zagora	29	9,82±0,21	4,23±0,19	2,3	5,37±1,1	45	7,20±0,6	4,98±0,28	1,4	7,64±0,42
Preslaven	40	8,97±0,30	4,53±0,08	1,9	6,79±1,2	42	10,0±0,2	2,53±0,11	3,9	3,46±0,19
Dŭlboki	40	10,05±0,20	3,43±0,04	2,9	4,34±0,7	38	9,56±0,22	2,51±0,14	3,8	3,64±0,22
Khrishteni	40	9,28±0,20	6,90±0,15	1,3	4,95±0,9	35	10,76±0,4	5,43±0,3	1,9	3,68±0,5
Dŭbovo	51	9,96±0,14	3,44±0,1	2,6	5,43±0,88	—	—	—	—	—

Table 5. Methemoglobin, reduced glutathione, and pyruvic acid in students living in the plant - Stara Zagora area in 1968 and 1969

Populated point	1968				1969			
	number studied	methemoglobin, %	reduced glutathione, mg%	pyruvic acid, mg%	number studied	methemoglobin, %	reduced glutathione, mg%	Pyruvic acid, mg%
Stara Zagora	29	4,73±0,63	30,32±6,5	0,96±0,2	50	3,90±0,50	18,90±0,90	0,86±0,14
Preslaven	40	3,29±0,45	43,23±7,60	0,89±0,16	42	2,10±0,32	19,22±0,95	0,93±0,17
Dŭlboki	40	4,41±0,47	29,36±5,0	0,80±0,10	38	3,20±0,30	19,18±0,10	0,96±0,17
Khrishteni	40	4,04±0,44	29,22±4,7	0,80±0,16	35	3,62±0,50	18,94-3,5	0,58±0,10
Dŭbobo	51	2,38±0,34	27,84±4,3	0,49±0,09	—	—	—	—

Urinary sulfur in those studied provided data on sulfur metabolism, as well as on the degree to which it is detoxified. As may be seen from the data in Table 6, in 1968, when the urinary sulfur found in all children

examined was approximately the same, there was a statistically reliable trend toward more complete utilization of metabolized sulfur in the organism with increase in inorganic sulfates, and a reduction in the quantity of neutral sulfur. The smaller quantity of ester-bound sulfates suggests a suppression of the detoxication processes and a decrease in the elimination of 17-ketosteroids, probably because of body tension attributable to the substantial concentrations of pollutants in the air. The ketosteroids excreted with the urine, esterified as sulfates, are significantly lower in the groups of children examined in 1968. The body appears to adapt gradually to atmospheric pollutants, evidenced by a considerable increase in the elimination of 17-ketosteroids, and reflected in the increased ester-bound sulfates excreted in the urine by the children in 1969. The excretion of neutral sulfur in the urine increased similarly.

The urinary excretion of ascorbic and dehydroascorbic acid by the children in the study group also diminished considerably in the two years when compared to control group and normal values. This is entirely reasonable, because an increased need for ascorbic acid in the presence of such oxidizers as nitrogen oxides, and a whole complex of toxic agents, had been anticipated.

The catalase and histaminase activity in the blood of the school children studied showed no statistically significant deviations as compared to that for the control group.

Responses to the statistical questionnaire with respect to the effect of air pollution on the population showed that of 1000 persons questioned, 85.6% were aware of a definitely unpleasant, specific, odor in their

respective villages and houses, and 85%-99% of those questioned reported a strong odor in Preslaven, Khrishteni, Dŭlboki, and Zora, all located closer to the plant. The odor was not as strong in Stara Zagora (60% of those questioned). To 24.8% of those questioned the odor was a permanent thing. According to the data, 80.7% of those questioned said air pollution had an unfavorable effect on home ventilation, particularly in the villages near the plant, and 64.8% said they noticed a difference in the pollution level as compared to past years. Of those, 58.5% said pollution had increased, 25.5% said it had decreased, and 15.7% said they noticed no difference. In addition to the smell, 22.2% of those responding reported cough, 19.5% vertigo, and 14.5% dizziness.

Table 6. Urinary sulfates for school children living in the plant - Stara Zagora area in 1968 and 1969

Populated point	1968					1969				
	number studied	total sulfur content, g/l	inorganic sulfates g/l	ester-bound sulfates, g/l	neutral sulfur, g/l	number studied	total sulfur content, g/l	inorganic sulfates g/l	ester-bound sulfates, g/l	neutral sulfur, g/l
Stara Zaroga	38	1,834±0,35	1,541±0,30	0,160±0,03	0,120±0,005	49	1,971±0,40	1,352±0,26	0,233±0,04	0,386±0,08
Kindegarden at the plant	24	1,216±0,23	1,012±0,20	0,120±0,02	0,084±0,001	18	3,224±0,21	2,283±0,22	0,445±0,01	0,496±0,03
Preslaven	40	1,760±0,40	1,142±0,23	0,300±0,06	0,297±0,07	32	1,712±0,34	0,888±0,16	0,457±0,08	0,367±0,05
Khrishteni	37	2,548±0,45	2,325±0,41	0,070±0,005	0,103±0,007	35	1,598±0,30	0,776±0,15	0,426±0,04	0,396±0,05
Dŭlboki	40	1,917±0,42	1,680±0,39	0,120±0,03	0,103±0,03	37	1,817±0,35	0,825±0,12	0,475±0,09	0,517±0,10
Dŭbovo	55	1,982±0,48	0,930±0,20	0,470±0,07	0,576±0,05	—	—	—	—	—

Conclusions

1. The air around the nitrogen fertilizer plant near Stara Zagora, is heavily polluted by hydrogen sulfide, nitrogen oxides, and ammonia. The sulfur dioxide, dust, and soot concentrations are within the limits of acceptable standards.

2. Hematological and biochemical studies of certain segments of the population living in the plant area showed changes in adaptation reactions, mineral metabolism, and oxidation-reduction processes, as well as changes in some hematological indices and in the immunobiological state, as a result of the effect of air pollution.

3. A statistical questionnaire distributed to the population evoked responses to the effect that air pollution in the plant area created an unpleasant, specific odor, that it had unfavorable repercussions upon home ventilation, and that it caused some of those responding to register subjective complaints.

The results of the study made of air pollution and of its effect on health led to the recommendation of the following program to prevent air pollution, and which was accepted in September 1970, by the Executive Committee of the Staro Zagorsk District People's Council:

1. provide equipment to trap the hydrogen sulfide emitted by the plant chimneys.

It is desirable to recommend the use of a suitable absorbant to trap the gas, and, following desorption, return it to the production process;

2. remove nitrogen oxides from gases emitted into the air, and provide installations to trap and use them;

3. adopt measures to improve the airtightness of manufacturing processes, and prevent production accidents;

4. move the kindergarten away from the plant and relocate it in an area approved by the State Sanitary Control;

5. accelerate the conversion of gas generators from coal to oil;

6. set-up priority organization of vacations elsewhere than in the plant area for children and students.

BIBLIOGRAPHY

1. Andreyeva, V. S. Voprosy okhr. mater. i detstva, 6, 1959, 25.
2. Bakh, Zubkova (according to V. O. Travina). Biokhimicheskiye metody issledovaniya [Biochemical Research Methods], 1961.
3. Balabayeva, L. Khigiena i zdraveopazvane (in printing).
4. David, Golek, Srbova (according to N. N. Pushkina). Biokhimicheskiye metody issledovaniya [Biochemical Research Methods], 1955.
5. Kazasov, P., Balabayeva, L., Petrova, G. Khigiena i zdraveopazvane , 5, 1968, 478.
6. Karakashov, A., Vichev, Ye. Mikrometodi i klin. laboratoriya [Micromethods and the Clinical Laboratory], 1966.
7. Lobova, Yu. I., Voytenko, G. N. Ukrainskiy biokhim. zh., 42, 1970, 81.
8. Todorov, Y. Klinichii i laboratorii izsledvaniya v detskata vozrast [Clinical and Laboratory Studies in Childhood], 1962.

9. Shefer, L., Yevstifeyeva, L. Labor. delo, 11, 1965, 679.

10. Grinert, Phillips. Arch. of Biochemistry, 30 1951, 217.

11. Glick, D. Methods of Biochemical Analysis, Vol. 11.

12. Joiner, McArdle, Thompson. Microanalysis in Medical Biochemistry. Ed. Wooton, 19, 1964.

13. Madgio, E., Salvatore. Biol. Sperimentale, 32, 1956, 378.